AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (Previously Presented) A cooling system for cooling a friction device, comprising:

a flow control device that controls a flow of cooling fluid through said friction device; and

a controller configured to estimate at least one temperature state that includes a bulk friction device temperature of said friction device based on an estimated heat rate of said friction device,

wherein said controller is configured to calculate a flow command based on said at least one temperature state and operates said flow control device based on said flow command,

wherein said controller is configured to determine at least one of approximate thermal inertia of said friction device and heat rejection of at least one of said friction device and said cooling system, and

wherein said controller is configured to estimate said at least one temperature state based on at least one of said approximate thermal inertia and said heat rejection.

2. (Cancelled).

3. (Previously Presented) The cooling system of claim 1, wherein said controller determines a friction device torque and a friction device slip speed and calculates said heat rate of said friction device based on said friction device torque and said friction device slip speed signal.

4. (Previously Presented) The cooling system of claim 1, further comprising:

a sump for collecting said flow of fluid; and

a sump temperature sensor that generates a sump temperature signal, wherein said at least one temperature state is further based on said sump temperature signal.

5. (Previously Presented) The cooling system of claim 1, wherein said at least one temperature state is further based on a current flow command.

6. (Previously Presented) The cooling system of claim 1, wherein said flow command is further based on said heat rate of said friction device and a sump temperature of said flow of fluid.

7-8. (Cancelled).

9. (Previously Presented) The cooling system of claim 1, wherein said at least one temperature state is a thermal energy of said friction device.

10. (Previously Presented) A method of controlling cooling of a friction device, comprising:

estimating a temperature state of a component of said friction device based on an estimated heat rate of said friction device;

determining a loop time of a thermal model of said friction device;

calculating a flow command based on said temperature state; and

controlling a cooling fluid flow through said friction device based on said flow command,

wherein said temperature state is estimated based on said loop time.

11. (Cancelled).

12. (Previously Presented) The method of claim 10, wherein said heat rate is based on a friction device torque and a friction device slip speed.

13. (Previously Presented) The method of claim 10, further comprising measuring a temperature of said fluid flow, wherein said temperature state is further based on said temperature.

14. (Previously Presented) The method of claim 10, wherein said temperature state is further based on a current flow command.

15-18. (Cancelled).

19. (Previously Presented) The cooling system of claim 10, wherein said temperature state is a thermal energy of said friction device.

20. (Previously Presented) A method of controlling cooling of a friction device, comprising:

calculating a heat rate of said friction device;

estimating a temperature state that includes a bulk temperature of said friction device based on said heat rate;

determining a flow command based on said temperature state;

determining a value based on the heat rate, heat rejection of said friction device, and sump temperature; and

operating a flow control device based on said flow command to control a cooling fluid flow into said friction device,

wherein said temperature state is estimated based on a thermal model of said friction device,

wherein said thermal model performs as a low-pass filter, and

wherein said low-pass-filter tracks said value.

21. (Original) The method of claim 20, further comprising:

determining a friction device torque; and

determining a friction device slip speed,

wherein said heat rate is based on said friction device torque and said friction device slip speed.

22-31. (Cancelled).

32. (Previously Presented) The cooling system of claim 1, wherein said temperature state is based on a loop time of a thermal model of said friction device.

33. (Previously Presented) The cooling system of claim 1, wherein said temperature state is based on a thermal module according to $T_{C\,deriv} = \left(\frac{1}{M_{friction\,device}}\right)\left(H_R - K_{diss}\left(T_C - T_{sump}\right)\right)$, where $T_{C\,deriv}$ is a derivative of said temperature state, $M_{friction\,device}$ is approximate thermal inertia of said friction device, H_R is said heat rate, K_{diss} is heat rejection of said friction device, T_C is said temperature state and T_{sump} is a sump temperature.

34. (Previously Presented) A cooling system for cooling a friction device, comprising:

a flow control device that controls a flow of cooling fluid through said friction device; and

a controller that:

estimates at least one temperature state that includes a bulk friction device temperature of said friction device based on an estimated heat rate of said friction device;

calculates a flow command based on said at least one temperature state;

operates said flow control device based on said flow command; and

estimates said at least one temperature state based on at least one of an approximate thermal inertia of said friction device and heat rejection of at least one of said friction device and said cooling system,

wherein said temperature state is based on a thermal model of said friction device,

wherein said thermal model performs as a low-pass filter, and

wherein said low-pass filter tracks $\frac{H_R}{K_{diss}} + T_{sump}$, where H_R is said heat rate, K_{diss} is heat rejection of said friction device, and T_{sump} is a sump temperature.

35. (Cancelled).

36. (Previously Presented) The cooling system of claim 34, wherein said low-pass filter tracks $\frac{H_R}{K_{diss}} + T_{sump}$ with a time constant of $\frac{M_{friction\,device}}{K_{diss}}$, where $M_{friction\,device}$ is approximate thermal inertia of said friction device.

37. (Previously Presented) The cooling system of claim 1, wherein said controller determines said approximate thermal inertia and said heat rejection, and

wherein said controller estimates said at least one temperature state based on said approximate thermal inertia and said heat rejection.

38. (Currently Amended) The cooling system of claim 37, wherein said approximate thermal inertia is in ~~joules per degree Celsius (J/°C)~~units of energy per units of temperature and said heat rejection is in ~~watts per degree Celsius (W/°C)~~units of power per units of temperature.

39. (Previously Presented) The method of claim 20, wherein said value is equal to a sum of said sump temperature and said heat rate divided by said heat rejection.

40. (Previously Presented) The method of claim 20, comprising:

determining said heat rate;

determining said heat rejection;

determining said sump temperature; and

calculating said value based on said heat rate, said heat rejection, and said sump temperature.

41. (New) The cooling system of Claim 1, wherein said friction device is a clutch of a transmission.

42. (New) The cooling system of Claim 41, wherein said controller is configured to determine heat rejection of said friction device.